

SDSU Systems Neuroscience 568/768

Professor:

Marty Sereno -- email: msereno@sdsu.edu
class time (2022): MWF 9:00-9:50 AM (opt.: F 8:00-8:50 AM)
Learning Glass lecture recording location: [SSW 2667](#)
office hours: Mon 10-11 or by appt.
lectures Zoom-streamed and recorded, tests on lecture content

Readings/Content:

readings, lecture videos (links, top of course homepage)
background reading (neuroscience reference texts):
Squire, Berg et al., eds. (2008/2013) *Fundamental Neuroscience*, 3rd/4th ed.
Kandel, Jessell, Schwartz, eds. (2008/2012) *Principles of Neural Science*, 5th/6th ed.
Nieuwenhuys, Voogd, van Huijzen (2008) *The Human Central Nervous System*, 4th ed.
background reading (undergrad neuroscience textbooks):
Nicholls et al. (2012) *From Neuron to Brain*, 5th ed.
Bear, Connors, and Paradiso (2006/2015) *Neuroscience: Exploring the Brain*, 3rd/4th ed.

Exams:

multiple question short-answer, each question with several subsections, test pdf link posted at 9 AM on exam day morning, email pics of filled-in exam pages by 11 AM
2 midterms, final (midterms: 24% each, final: 32%), and short final paper (20%)
old pdf answer keys from my similar UCSD Systems Neuroscience course [here](#) and [here](#)

Learning Objectives:

Students will be able to do the following:

- (1) describe neuronal electrochemistry, development, and relation to simple dendritic, Hebbian, and attractor models
 - (2) diagram neuroanatomical structures/connections from low to high levels in visual, somatosensory, auditory sensory systems
 - (3) diagram structures/connections involving superior colliculus, cerebellum, striatum, motor cortex, and limbic systems
 - (4) analyze sequential processing stages in visual, somatosens., and auditory systems from signals and systems perspective
 - (5) describe neural models of eye movement planning, hierarchical motor control, and body position and orientation
- N.B.: consult with me if a disability hinders your performance so we can use University resources to maximize learning

Lecture Topics: (Spring 2022)

Week of Jan 17 (WF) -- Introduction

introduction to course, folk theory of brain function
resting/Nernst/reversal potential

Week of Jan 24 (MWF) -- Cellular Physiology

action potential, voltage-gated channels
voltage-sensitive dendritic currents, bursting neurotrans.-gated post-synaptic potentials, NMDA, LTP/STDP
grad lecture: Hodgkin-Huxley, integrate-and-fire models

Week of Jan 31 (MWF) -- Relation to Neural Models

current flow in dendrites, equivalent circuits
simple Hebbian network model of orientation selectivity
simple attractor network model, energy analysis
grad lecture: covariance/eigenvector analysis Hebbian learning

Week of Feb 07 (MWF) -- Neural Development

blastula, gastrula, neural plate, neural tube, optic cup
cylindrical coords, temporal lobe formation, 'rule of Sereno'

later development, cortical subplate, gyrification

Week of Feb 14 (MWF) -- Visual System I

retinal circuitry, origin of processing streams
retina to dLGN as a conformal map, layers
visual cortical maps: V1, V2, MT and the rest
grad lecture: cortical area development, achiasmatic sheepdog

Week of Feb 21 (MWF) -- Visual System II

cortical layer scheme, edges/brightness/motion in V1
V2 modules, simple/complex/hyper, 1st midterm review
1st Midterm Exam -- Fri, Feb 25

Week of Feb 28 (MWF) -- Visual System III

Gabor filter model, aperture prob for color, pattern translation
aperture prob complex motion, pos. invariance, contour analog
cortical-wide mechanisms of visual attention
grad lecture: explicit V1-to-MT model, Horn and Schunck

Week of Mar 07 (MWF) -- Somatosensory System

somatosensory receptor types, spinal cord
muscle diagram, ascending paths: dorsal column, spinothalamic
somatosensory cortical areas, discontinuities, plasticity
grad lecture: smoothness constraint, line processes, stereo

Week of Mar 14 (MW) -- Auditory System I

hair cell receptors, lateral line, electric fish
cochlear structure/transduct., 1D vs. 2D, mammalian brainstem
[no classes Fri]

Week of Mar 21 (MWF) -- Auditory System II

cochlear nuclei responses, auditory streams
nucleus laminaris coincidence detection
construction of the owl space map
grad lecture: auditory thalamus, cortex, freq vs. pitch

Week of Mar 28 (no class) -- SPRING BREAK

[Mon/Wed/Fri: no class]

Week of Apr 04 (MWF) -- Motor System I

bat echolocation and speech sound processing
gaze stabilization (VOR, OKN, pursuit)
superior colliculus retinal/motor maps, double-step remapping
grad lecture: bat FM, phonetics, auditory attention

Week of Apr 11 (MWF) -- Motor System II

multisensory map alignment: superior colliculus, VIP, LIP
motor system overview, spinal/brainstem pattern generators
motor cortex, 2nd midterm review
grad lecture: spatial->temp & temp->spatial, WTA, human VIP

Week of Apr 18 (MWF) -- Motor System III

2nd Midterm Exam -- Mon, Apr 18
cerebellum: connections, microanatomy, learning
striatum: connectional/funct overview, hierarchical sequencing
grad lecture: origin of language I: vocal learning

Week of Apr 25 (MWF) -- Limbic System

connectional overview limbic system
hippocampus: H.M./intermed. term memory vs. inertial guidance
head direction and grid cells, attractor models
grad lecture: origin of language II: language and scenes

Week of May 02 (MW) -- Neuroimaging EEG/MEG

source EEG/MEG, MRI, spin vs. precess, Bloch equation
Fourier transform, relation to MRI image formation

May 09 -- Final Exam 8-10 AM

Graduate students: final paper due May 13